

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing

(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION

See paragraph 2 below

International application No.
PCT/GB2004/004806

International filing date (day/month/year)
16.11.2004

Priority date (day/month/year)
24.11.2003

International Patent Classification (IPC) or both national classification and IPC
G02F1/355, G02B6/134

Applicant
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1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/GB2004/004806

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
 - ☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ in written format
 - ☐ in computer readable form
 - c. time of filing/furnishing:
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in computer readable form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/GB2004/004806

Box No. II Priority

1. ☒ The following document has not been furnished:

- ☒ copy of the earlier application whose priority has been claimed (Rule 43*bis*.1 and 66.7(a)).
☐ translation of the earlier application whose priority has been claimed (Rule 43*bis*.1 and 66.7(b)).

Consequently it has not been possible to consider the validity of the priority claim. This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.
3. ☐ It has not been possible to consider the validity of the priority claim because a copy of the priority document was not available to the ISA at the time that the search was conducted (Rule 17.1). This opinion has nevertheless been established on the assumption that the relevant date is the claimed priority date.
4. Additional observations, if necessary:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-7
	No: Claims	
Inventive step (IS)	Yes: Claims	
	No: Claims	1-7
Industrial applicability (IA)	Yes: Claims	1-7
	No: Claims	

2. Citations and explanations

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

V. Reasoned statement under Rule 43bis.1(a)(i)

V.1 Reference is made to the following documents:

- D1: Domenech I et al.: "Blue light by SHG in diode pumped LiNbO₃ waveguides", Phys.Stat.Sol.(a), vol. 192, no. 1, pp. 135-138 (2002), XP-2318439,
D2: Barry I E et al.: "Microstructuring of lithium niobate using differential etch-rate between inverted and non-inverted ferroelectric domains", Mat. Lett., vol. 37 (1998), pp. 246-254, XP-4256024,
D3: Twu R-C et al.: "Zn indiffusion waveguide polarizer on a Y-cut LiNbO₃ at 1.32- μ m wavelength", IEEE Phot. Techn. Lett., vol. 12 (2000), no. 2, pp. 161-163, XP-912637,
D4: Suhara T et al.: "Fabrication of Zn:LiNbO₃ waveguides by diffusing ZnO in low-pressure atmosphere", Jpn. J. Appl. Phys., vol. 39 (2000), pp. L864-L865, XP-977869,
D5: Yang C et al.: "Studies of photorefractive crystals of double-doped Ce,Fe-LiNbO₃", Opt. Comm., vol. 175 (2000), pp. 247-252, XP-4189588.

V.2 Claim 1 lacks an inventive step, as document D1 (see abstract, introduction and section "Experimental procedure") discloses a method of fabricating an optical waveguide comprising the sequence of steps of:

- (a) providing a sample of lithium niobate having one or more gratings of periodic domain inversion defined therein ["periodic poled lithium niobate (PPLN)"],
(b) diffusing zinc into, and hence altering the refractive index of, the lithium niobate so as to form an optical waveguide structure within the lithium niobate (see abstract).

However, the disclosure of D1 differs from the specifications of claim 1 in that:

- step (a): the gratings of periodic domain inversion are not defined by electric field poling,
- step (b): the zinc is not diffused into the lithium niobate from a layer of metallic zinc which is applied to the "z-face" of the sample (for a non-clarity objection

against the reference "z-face", see section VIII.).

Several methods as known in the art for (a) producing lithium niobate samples with gratings of periodic domain inversion and for (b) diffusing zinc into lithium niobate. ~~The particular choice of a method is usually based on the equipment that~~ is available to a skilled person. It is also noted that there is no interaction between steps (a) and (b), such that the skilled person would choose the technology for carrying out step (b) independently from the technology for carrying out step (a) ("aggregation or juxtaposition of features", see Guidelines C-IV, 9.5).

For the reasons given above, the skilled person could be expected to replace the methods taught by D1 of producing a periodically poled structure and of forming a waveguide by zinc-indiffusion by alternative, equivalent methods.

Having regard to the periodically poled structure (a), he would find document D2 (see section "2. Materials and methods" and Fig. 1), which teaches the definition of a grating of periodic domain inversion in lithium niobate by electric field poling (see, in particular, page 249, left hand column).

Having regard to the formation of a waveguide by zinc-indiffusion, he would find document D3 (see section "II. Experiments"), which teaches the application of a layer of metallic zinc, patterning the layer according to the waveguide structure and heating the sample to cause the zinc to diffuse into, and hence alter the refractive index of, the lithium niobate.

Thus, the subject-matter of claim 1 lacks an inventive step having regard to the disclosure of D1 in combination with that of D2 and D3 [Article 33(3) PCT].

It appears from the description (see page 4, lines 11-23 and page 8, lines 14-26) that it is an essential feature of the invention that the method steps (a) and (b) are performed in a specific order, i.e. that the waveguide is formed by zinc-indiffusion into an existing periodically poled structure. It is noted that this specific order is also taught by D1.

V.3 Having regard to the dependent claims:

As to claim 2, the subject-matter of this claim appears to be included in claim 1, so the definitions of claim 2 seem superfluous.

As to claim 3, document D2 [see Fig. 1(a) and page 249, left hand column] teaches electric field poling by application of an electric field across the sample via gel electrodes applied to the +z and -z faces of the sample.

As to claim 4, the use of a film of metallic nickel as an adhesive layer for zinc is known from D3 (see section "II. Experiments").

As to claim 5, the steps specified in this claim are known from D3 (see section "II. Experiments"). Although the heating/cooling rate taught by D3 is slightly bigger than that defined by claim 5 (10 °C/min instead of 6 °C/min), no inventive difference can be recognized, as a skilled person would perform experiments, starting from the value given in D3, in order to find to optimum value for his equipment, and he could be expected to find the value defined in claim 5.

As to claims 6 and 7, the use of lithium niobate doped with magnesium, cerium or iron is well known in the art (for magnesium, see D4, "1. Introduction", second paragraph; for cerium and iron see D5, abstract). It is noted that there is no interaction between these dopants and the method steps according to claim 1 ("aggregation or juxtaposition of features", see Guidelines C-IV, 9.5).

VIII. Certain observations on the international application (Article 6 PCT)

VIII.1

As already noted in V.2 (last paragraph), a specific order of the method steps appears to be essential for the invention. However, the present wording of does not define a precise sequence of method steps.

Furthermore, claim 1 is not clear, as the reference to "a z-face of the sample" does not unambiguously define the sideface of the sample that the zinc layer is applied to. It is recognized that the designations "x-, y- and z-axis" are clear for a person skilled in the art of using lithium niobate, as these axes relate to the crystal orientation. However, in the wording of claim 1 the definition of a "z-face" relates to "the sample", and within the sample, a coordinate system can be arbitrarily oriented.

VIII.2

The subject-matter of claim 2 is included in the definitions of claim 1, and claim 2 is superfluous.